

Fig. 10. Status of long-term operation test. 30 day long-term operation tests were completed successfully, with no significant changes in the temperature of the cable or other sections.

B. Cooling system tests

In this project, the direct cooling method has been selected as the refrigeration system. In this system, liquid nitrogen flows out from one cable termination, through the circulating pumps and refrigerators, and then back to the other cable termination directly. The number of pumps and refrigerators is determined by system conditions and redundancy factors. Fig. 11 shows the flow diagram of the cooling system for the Asahi substation. A Stirling type cryocooler, having the capability of 1 kW @77 K or 0.8 kW @67 K, is applied. The number of cryocoolers was determined to be 6. Four are used in normal operation and two are retained in a stand-by state. Two liquid nitrogen pumps are placed in parallel and driven alternatively for a set period of time.

Prior to the long-term test at the Asahi substation, the minimal cooling system, which consists of two refrigerators and a pump, was tested by connecting it to the 30 meter HTS cable system [8]. After this element test, as shown in Fig. 12, the cooling system consisting of three refrigerators and two pumps was constructed at a factory of Mayekawa. The configuration of this cooling system is same as that for Asahi substation. Dummy load made of a heater inserted in a short length insulation-pipe is used instead of connecting an actual HTS cable to the cooling system. Using this cooling system, various performance tests are being carried out.

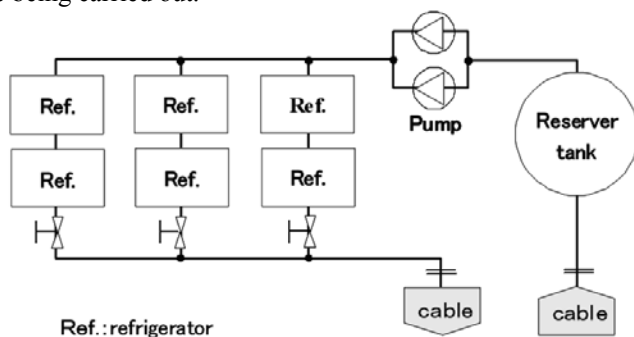


Fig. 11. Flow diagram of the cooling system for the Asahi substation.



Fig. 12. Overview of the cooling system constructed at Mayekawa's factory. This cooling system has the same configuration as that for Asahi substation, though the number of refrigerator is three instead of six.

VI. CONCLUSION

Prior to the connection to the actual grid in the Asahi substation, performance verification testing of the 30-meter HTS cable system was completed in April, 2010. Following that, performance verification testing of the liquid nitrogen cooling system is now underway. After completing the test, the cable system will be installed and constructed at the Asahi substation for the long-term demonstration test to be started in 2011.

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